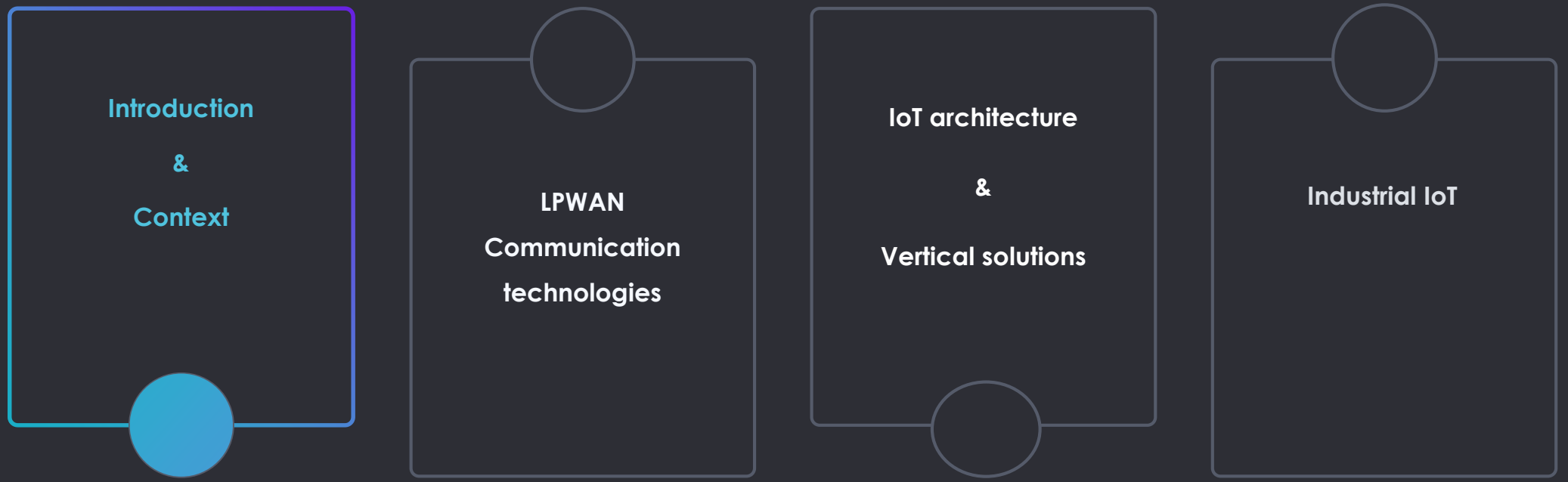
IoT: The new Insdustrial revolution

Nafissatou NDIAYE

Key topics to be discussed



IoT Market insights

75 Billions

IoT connexions by 2025
Against 6,3 Billions in 2016

+++

Devices for Industrial IoT and the rest for general public usage

5%

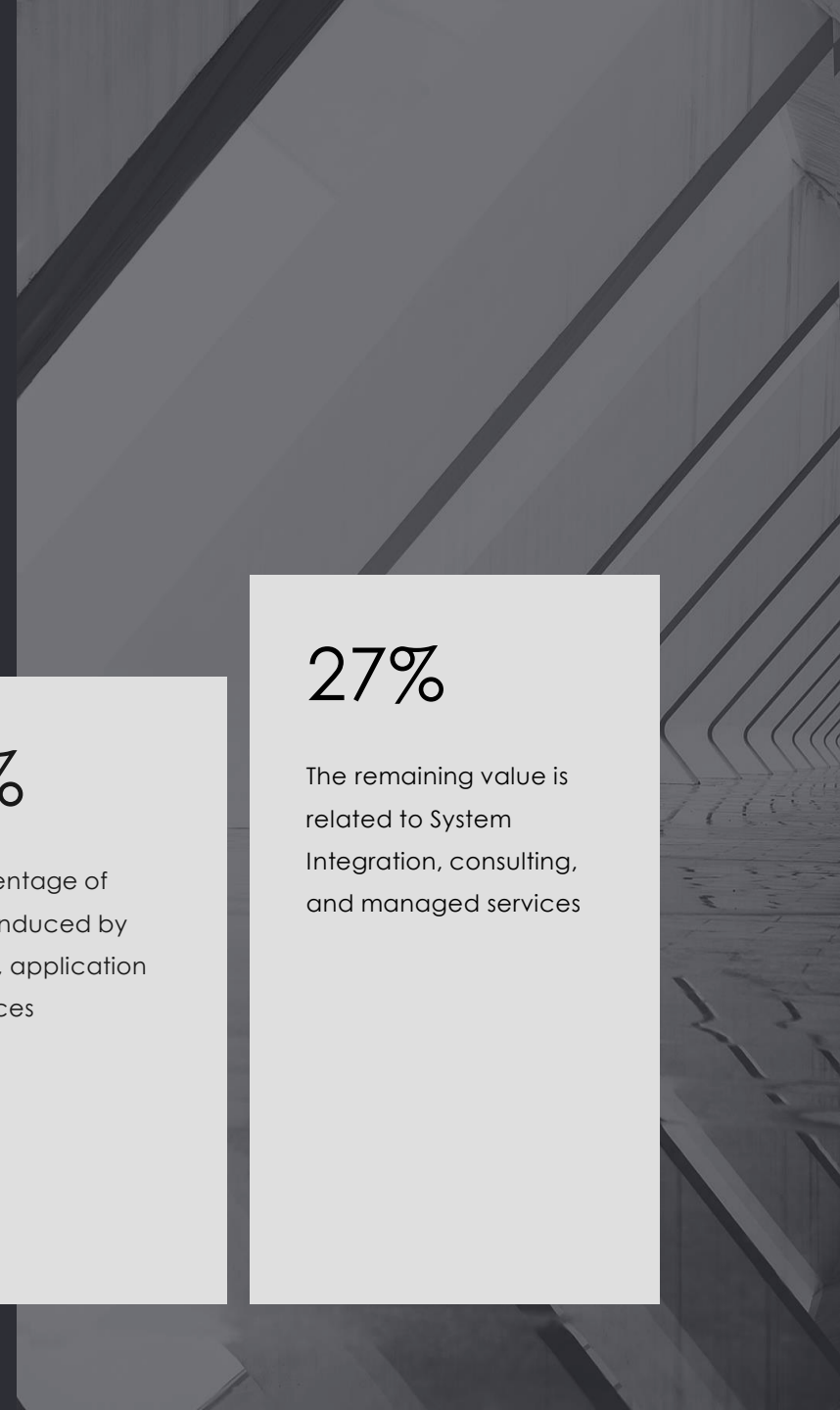
The percentage of revenue related to connectivity by 2025

68%

The percentage of revenue induced by platforms, application and services

27%

The remaining value is related to System Integration, consulting, and managed services



IoT Market insights

25,2 Billions

IoT connexions by 2025
Against 6,3 Billions in 2016

13,8 Billions

Devices for Industrial IoT and 11,4 for general public usage

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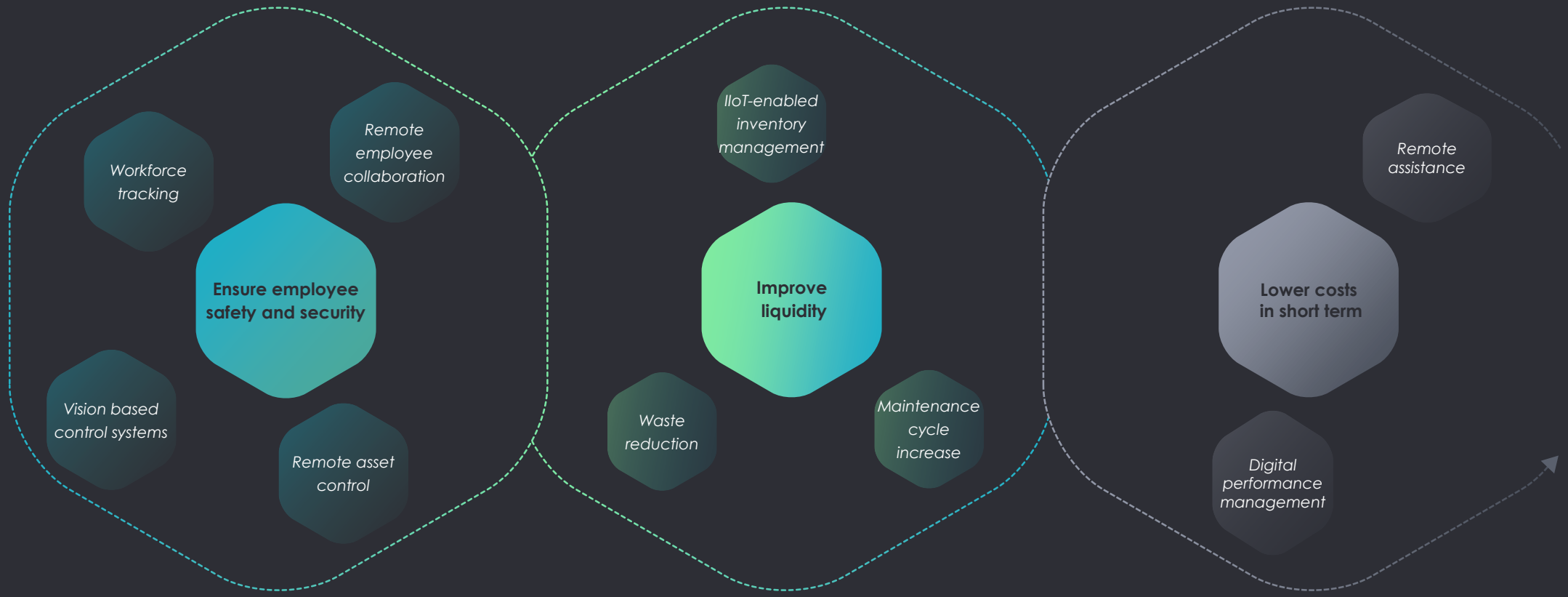
What are IoT levers in the “new world”?



Safeguarding operations

-10 to -35% inventory
-20% waste
-10 to -15% maintenance costs

20 to 40% labor productivity
-10 to -40% service cost

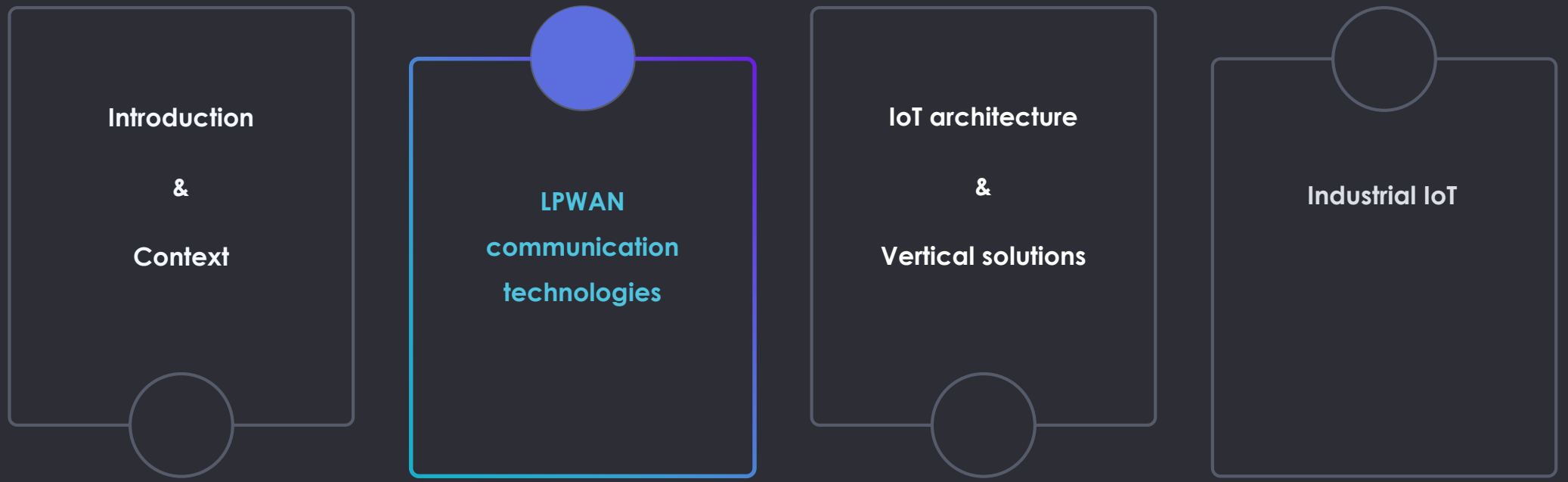
What are IoT levers in the “new world”?

Strategic enabler

Up to five-percentage-point overall equipment effectiveness

-2 to -5% spend

Case dependent
5 to 8% revenue


Introduction
&
Context
LPWAN
communication
technologies
IoT architecture
&
Vertical solutions
Industrial IoT

LPWAN technologies: LoRa

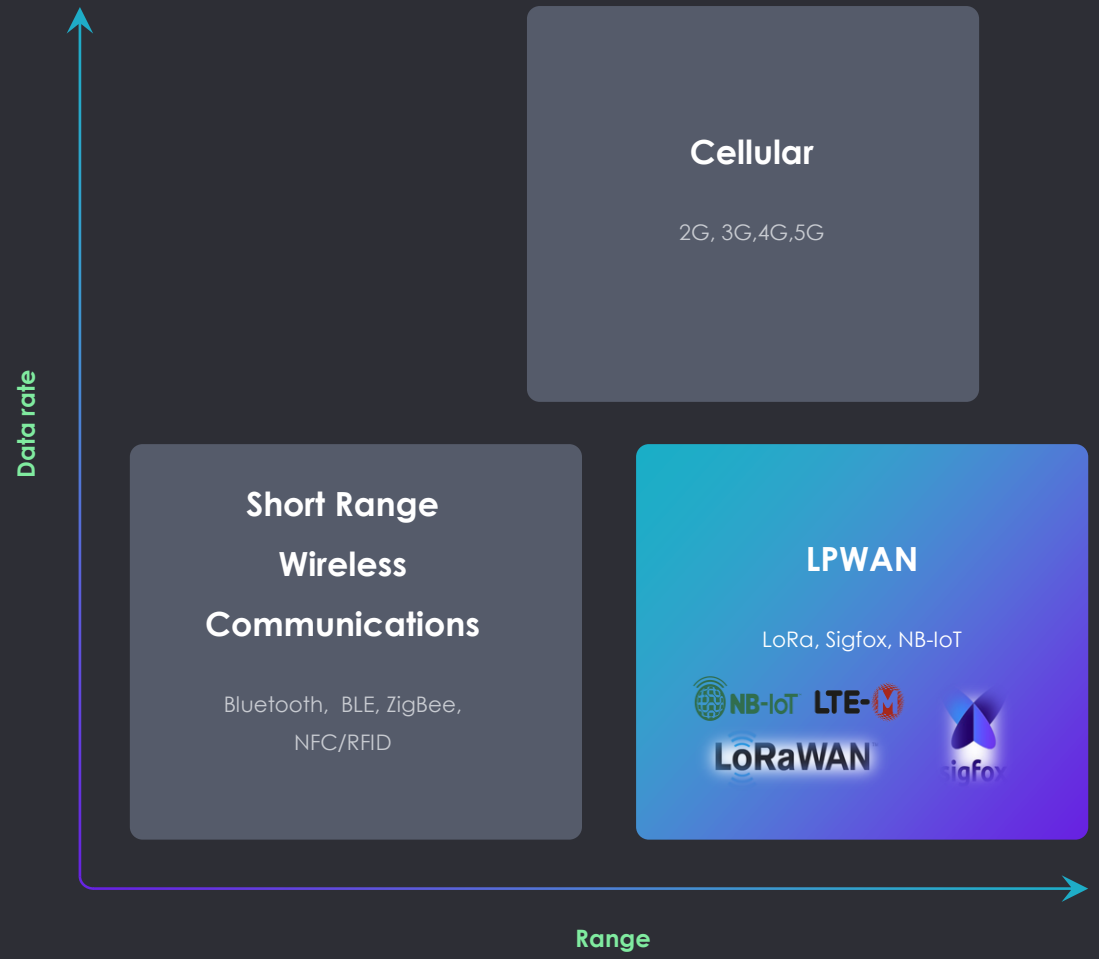
LPWAN

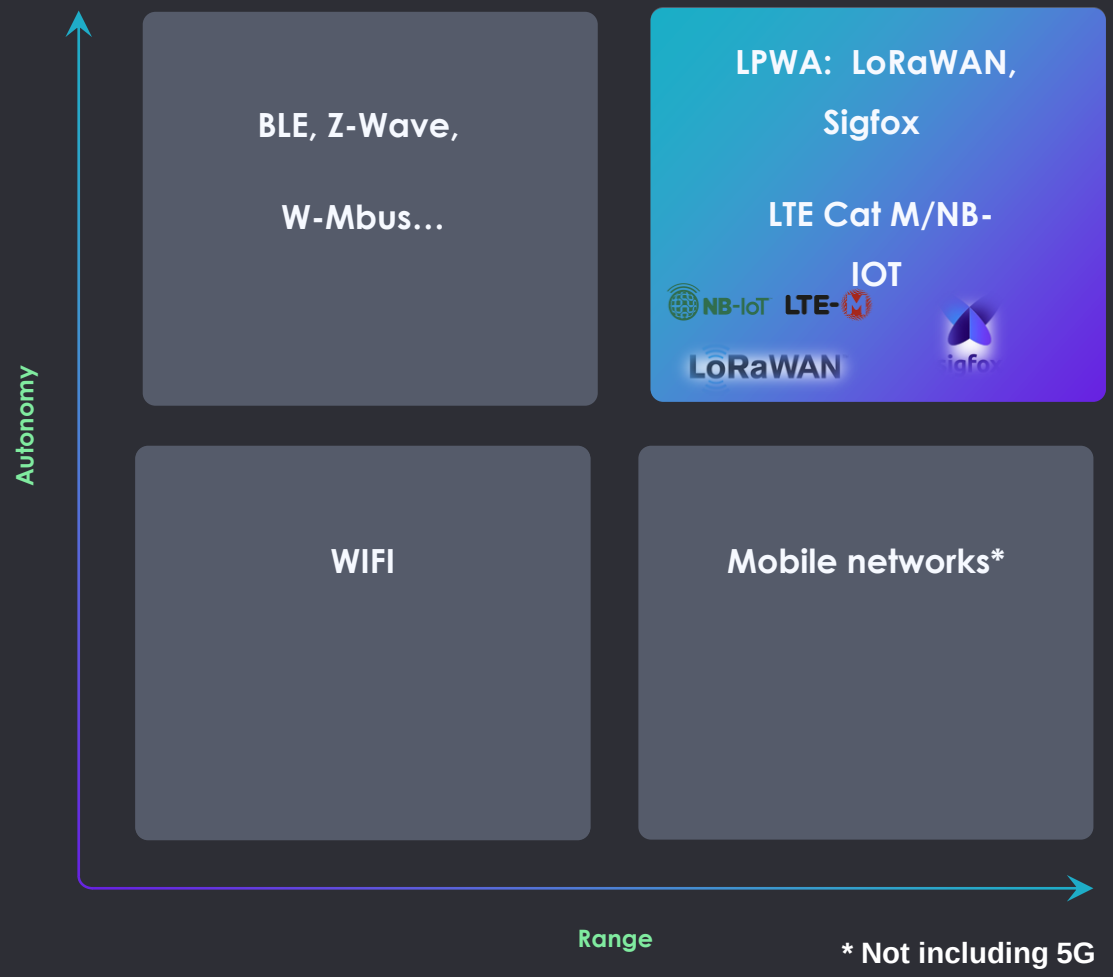
- Low power wide area networks
  Sigfox, LoRa, NB-IoT
- Low data rate, Long range

LoRaWAN

- Created in 2009 by a French start –up Cycleo
- Long range wide area network

LoRa technical characteristics overview



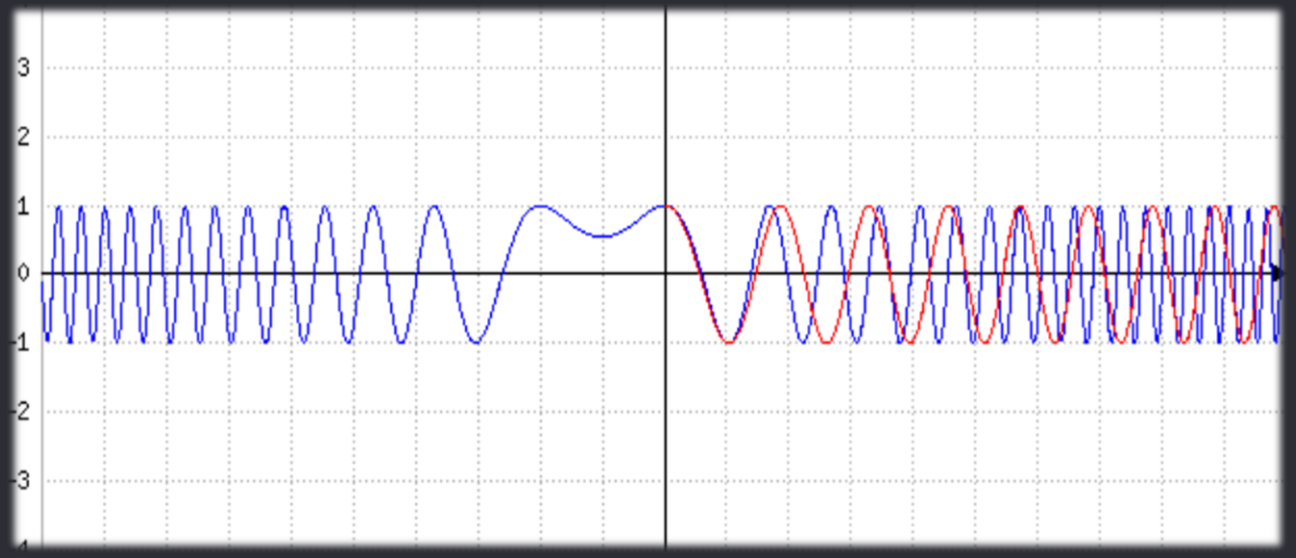


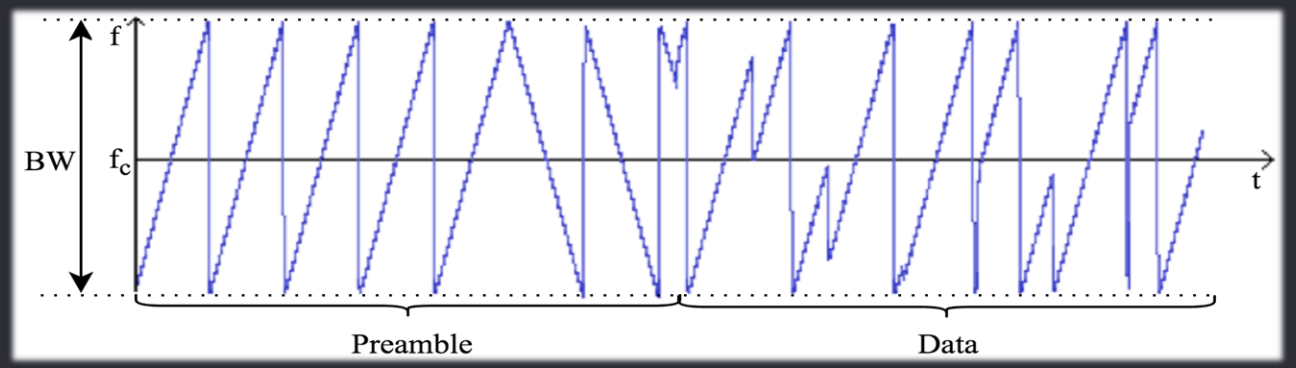
Low Power, small data rate and long range

LPWAN technologies comparison

	Sigfox	LoRaWAN	NB-IOT
Modulation	BPSK	CSS	QPSK
Frequency	unlicensed	unlicensed	licensed
Bandwidth	100Hz	250kHz & 125kHz	200kHz
Adaptative data rate	No	Yes	No
Max data rate	100bps	50kbps	200kps
Bidirectional	Limited/ Half duplex	Yes/Half duplex	Yes/Half duplex
Max messages/day – Payload	140 – 12 bytes (UL) 4 – 8 bytes (DL)	Unlimited-243 bytes	Unlimited
Range	[10, 40] km	[5, 20] km	[1, 10] km

LoRa modulation





LoRaWAN message structure

Chirp spread modulation technique

$y(t) = A \cos(\omega t + \delta(t))$

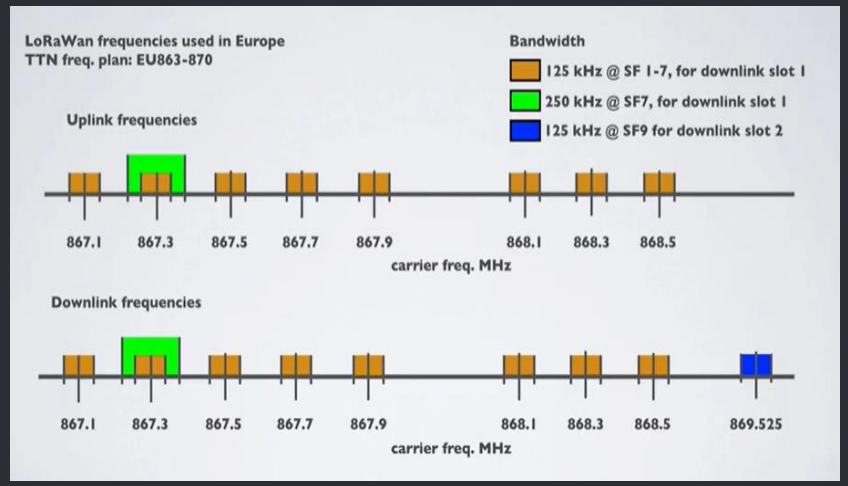
$\delta(t)$:polynomial function, A, ω: constant

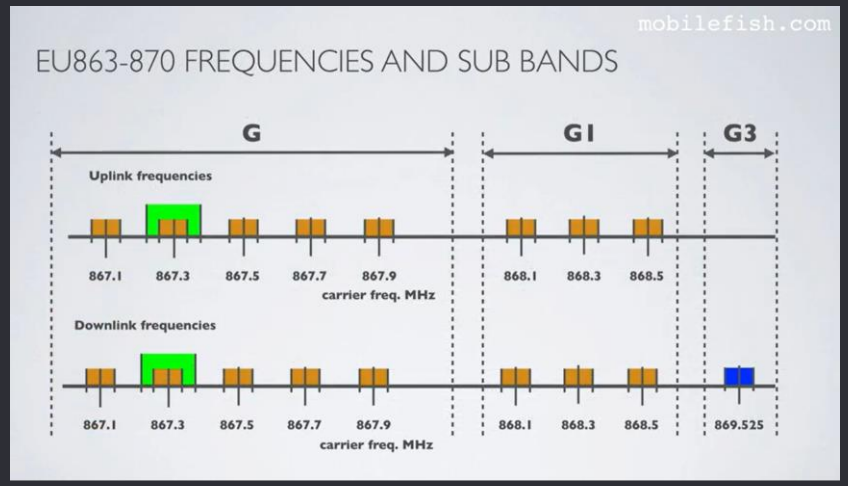
Linear frequency variation

Advantages:

- Tolerance to interferences, noise, Doppler effect
- Long range communications
- Low cost

ISM Band Used for LoRaWAN

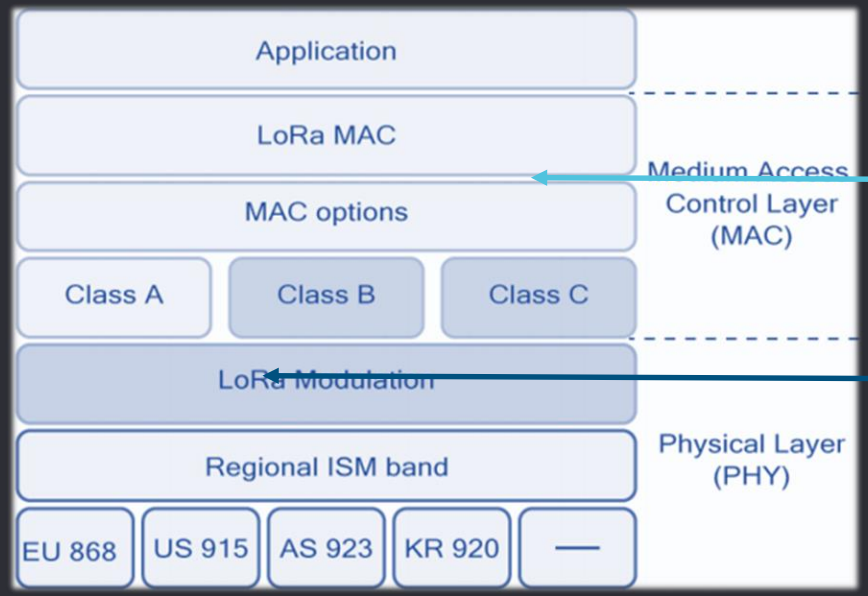




EU868 ISM Band

- Split in 5 sub bands (G, G1, G3)
- 3 required channel frequency 868.10, 868.30 868.50
- 8 channels for UL and DL and one additional channel for RX2 DL(869.525 MHz)
- Duty cycle (1 to 10%)
- Maximum EIRP value of +16 dBm

LoRaWAN protocol



Class A device is the minimal/required implementation
Class B, beacon, reachable at define time slot
Class C, continuous, can be almost continuously reached

MAC commands are used for configurations

PHYPayload:

MHDR	MACPayload	MIC

or

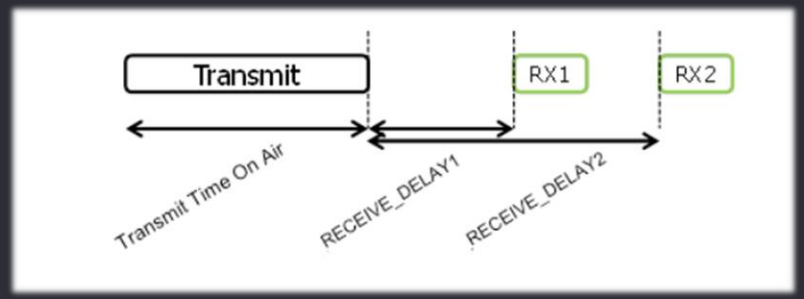
MHDR	Join-Request[4]	MIC

or

MHDR	Join-Accept[4]	MIC

CID	Command	Transmitted by: End-device	Transmitted by: Network Server	Brief Description
0x02	***LinkCheckReq***	x		Used by an end-device to validate its connectivity to a network.
0x02	***LinkCheckAns***		x	Answers ***LinkCheckReq***. Contains the received signal power estimation, which indicates the quality of reception (link margin) to the end-device.
0x03	***LinkADRReq***		x	Requests the end-device to change data rate, TX power, redundancy, or channel mask.
0x03	***LinkADRAns***	x		Acknowledges ***LinkADRReq***.
0x04	***DutyCycleReq***		x	Sets the maximum aggregated transmit duty cycle of an end-device.
0x04	***DutyCycleAns***	x		Acknowledges ***DutyCycleReq***.
0x05	***RXParamSetupReq***[7]		x	Sets the reception slot parameters.
0x05	***RXParamSetupAns***	x		Acknowledges ***RXParamSetupReq***.
0x06	***DevStatusReq***		x	Requests the status of the end-device.
0x06	***DevStatusAns***	x		Returns the status of the end-device, namely its battery level and its radio status.
0x07	***NewChannelReq***		x	Creates or modifies the definition of a radio channel.
0x07	***NewChannelAns***	x		Acknowledges ***NewChannelReq***.
0x08	***RXTimingSetupReq***[7]		x	Sets the timing of the reception slots.
0x08	***RXTimingSetupAns***	x		Acknowledges ***RXTimingSetupReq***.
0x09	***TXParamSetupReq***[7]		x	Used by a Network Server to set the maximum allowed dwell time and MaxEIRP of end-device, based on local regulations.
0x09	***TXParamSetupAns***	x		Acknowledges ***TXParamSetupReq***.

LoRaWAN class A device



RECEIVE-DELAY1= 1s
RECEIVE-DELAY2= 2s

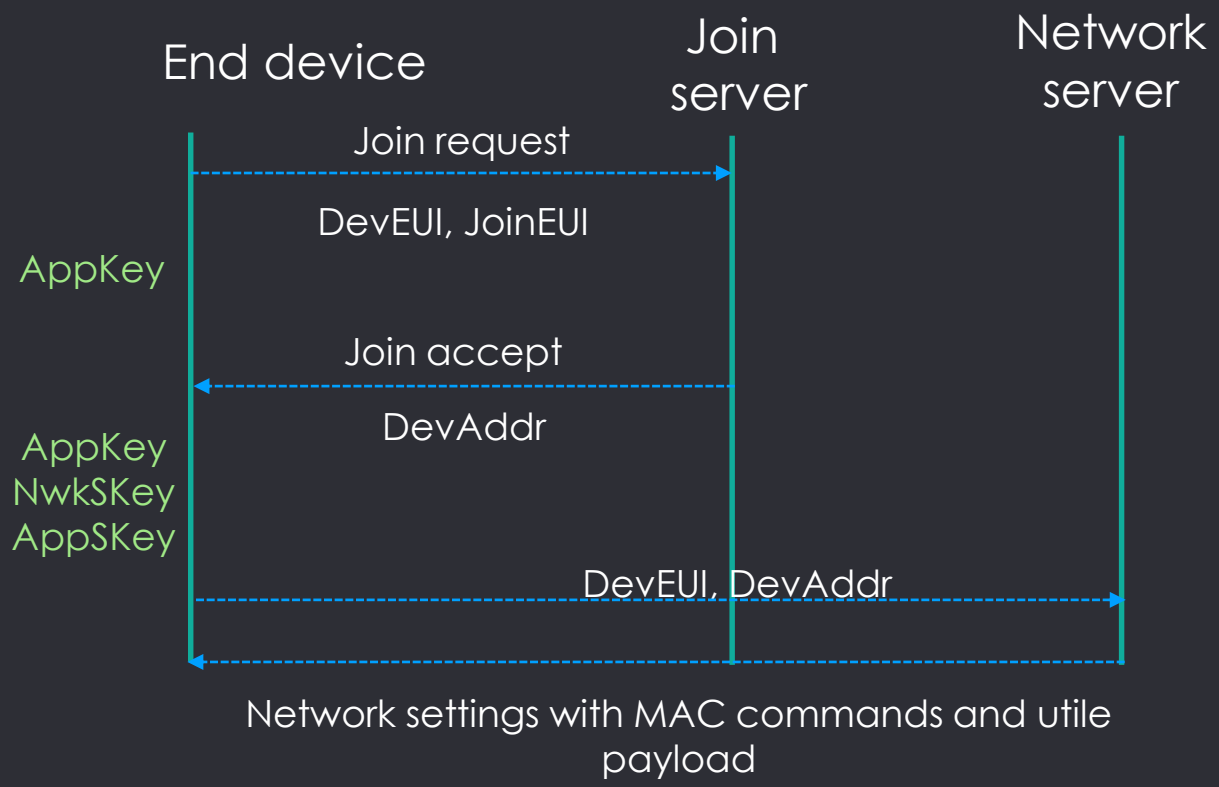
JOIN_ACCEPT_DELAY1=5s
JOIN_ACCEPT_DELAY2=6s

Transmit data in an optimized manner:

- Go on idle after transmission and receive response windows
- Adaptative Data Rate (ADR): Use of fastest DR with minimum TX power
- Long battery life

Example of a device activation

Over the air activation (OTAA)

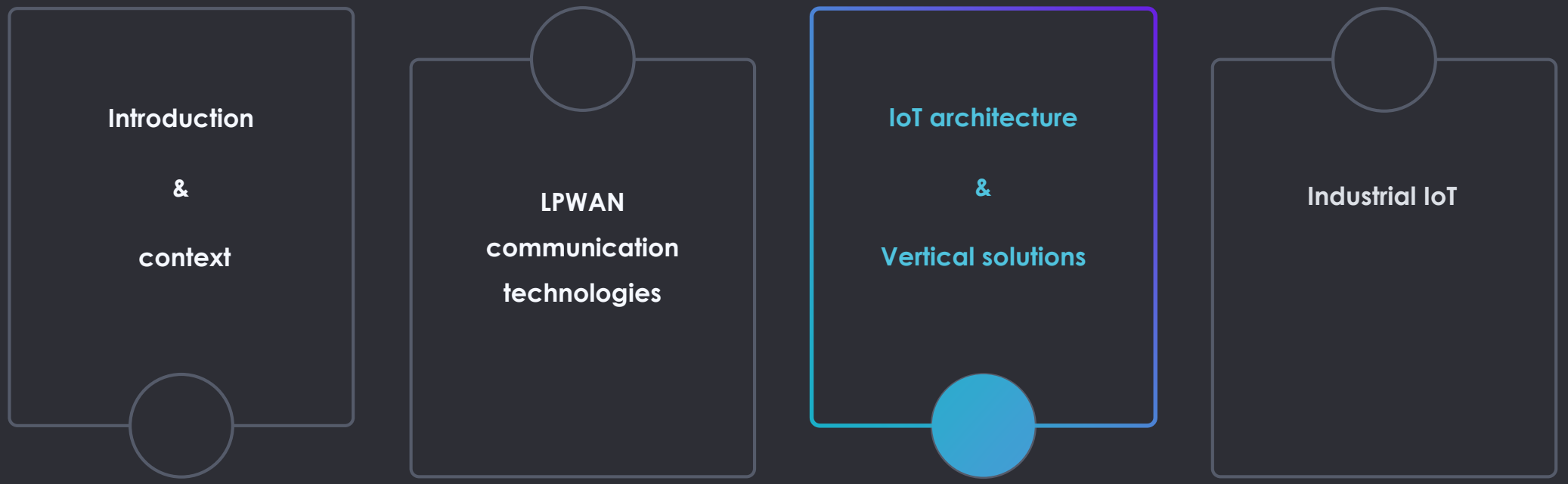


Size (octets)	8	8	2
Join-Request payload	JoinEUI	DevEUI	DevNonce

Size (octets)	3	3	4	1	1	(16) optional
Join-Accept payload	JoinNonce	NetID	DevAddr	DLSettings	RXDelay	CFList

NwkSKey = aes128_encrypt(AppKey, 0x01 | JoinNonce | NetID | DevNonce | pad16)

AppSKey = aes128_encrypt(AppKey, 0x02 | JoinNonce | NetID | DevNonce | pad16)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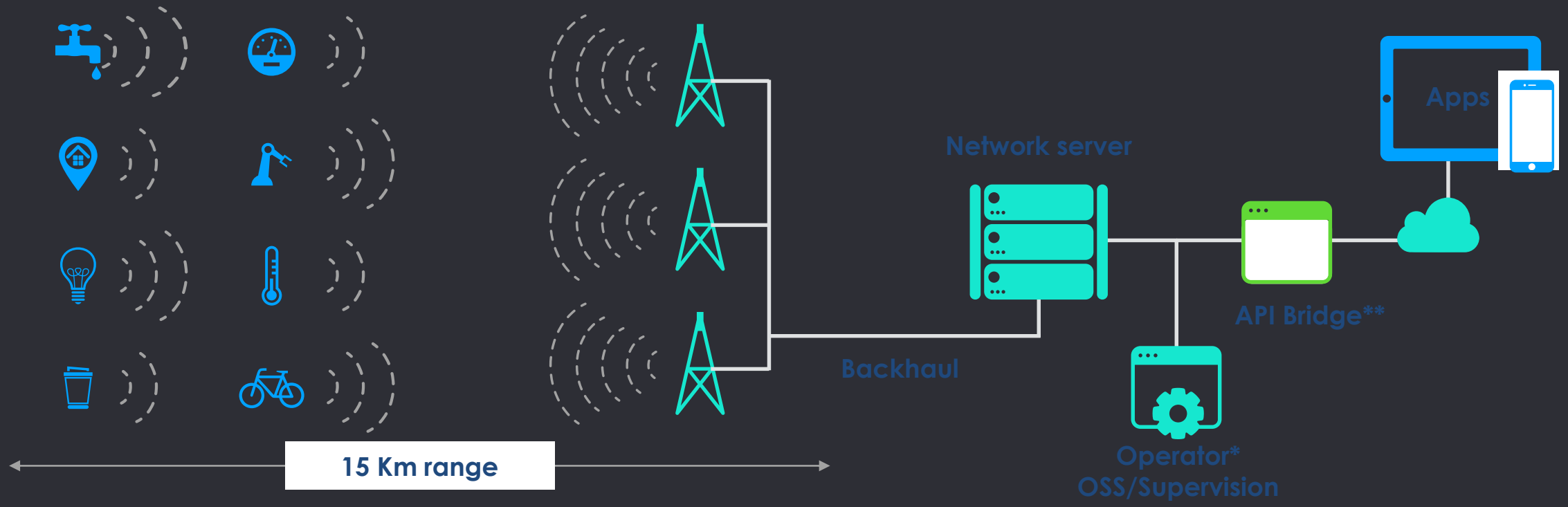
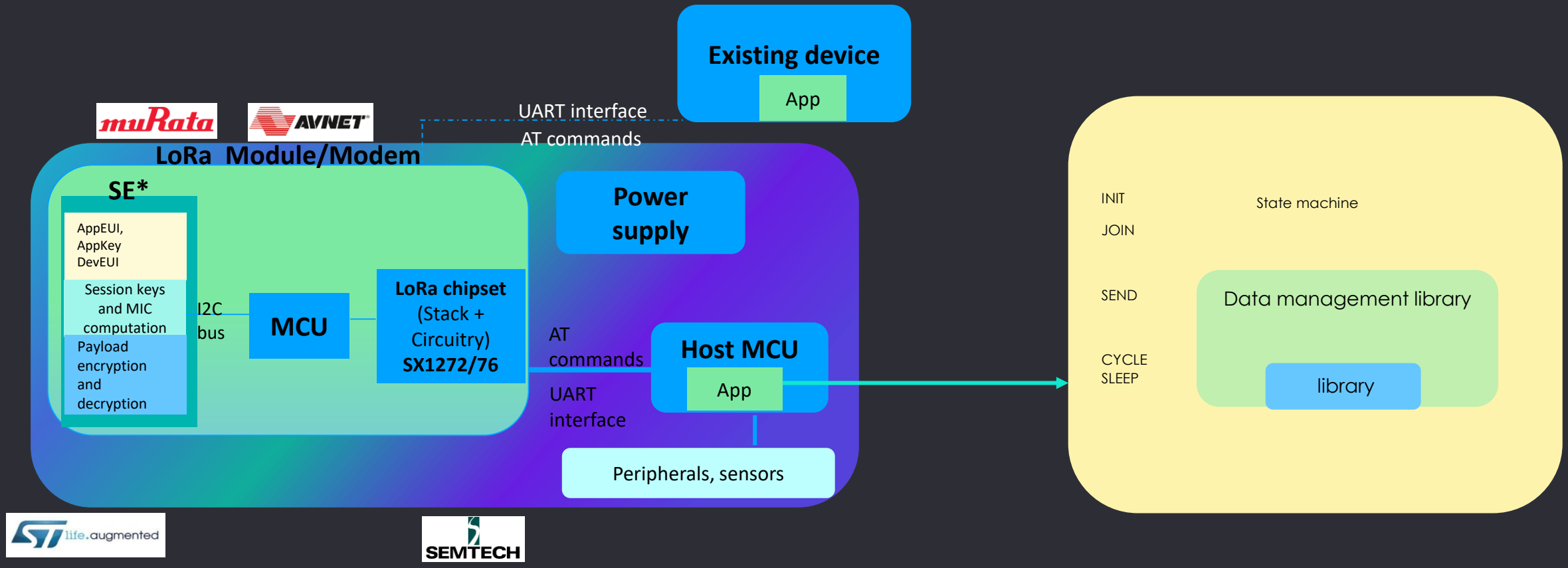
LPWAN IoT architecture



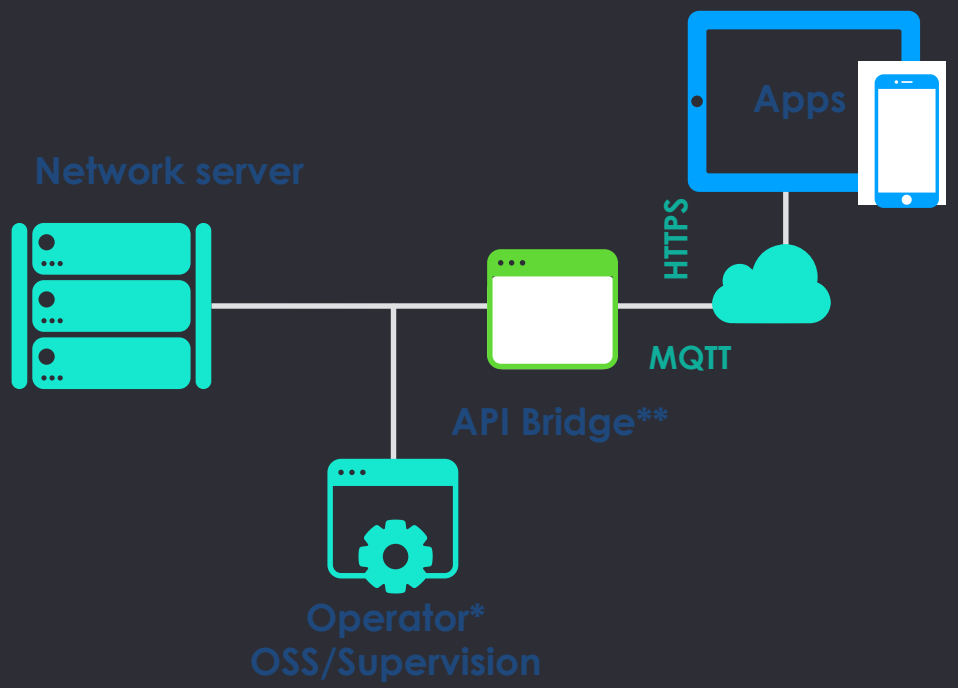
*Can also be vendors or enterprises

** Data exposure

LoRaWAN device implementation example



We have received the data, what next?



Data visualization /Monitoring and control

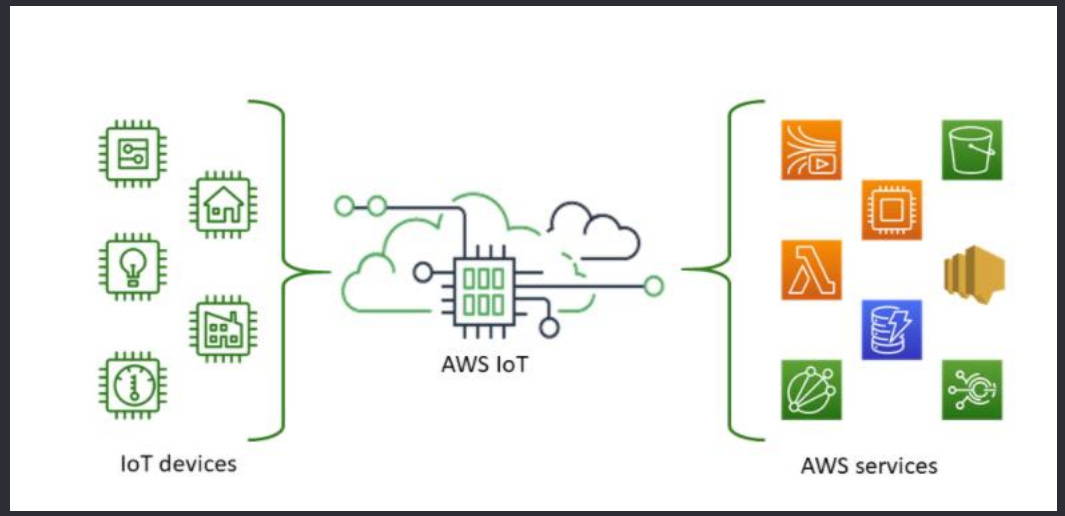
Wonderware by Schneider Electric

amazon web services

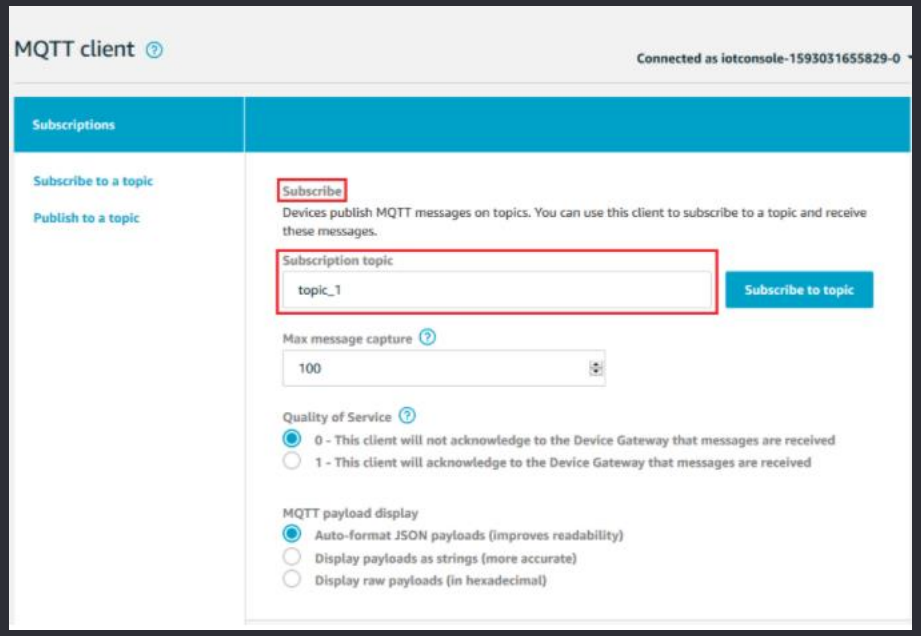
Azure

IBM Bluemix™

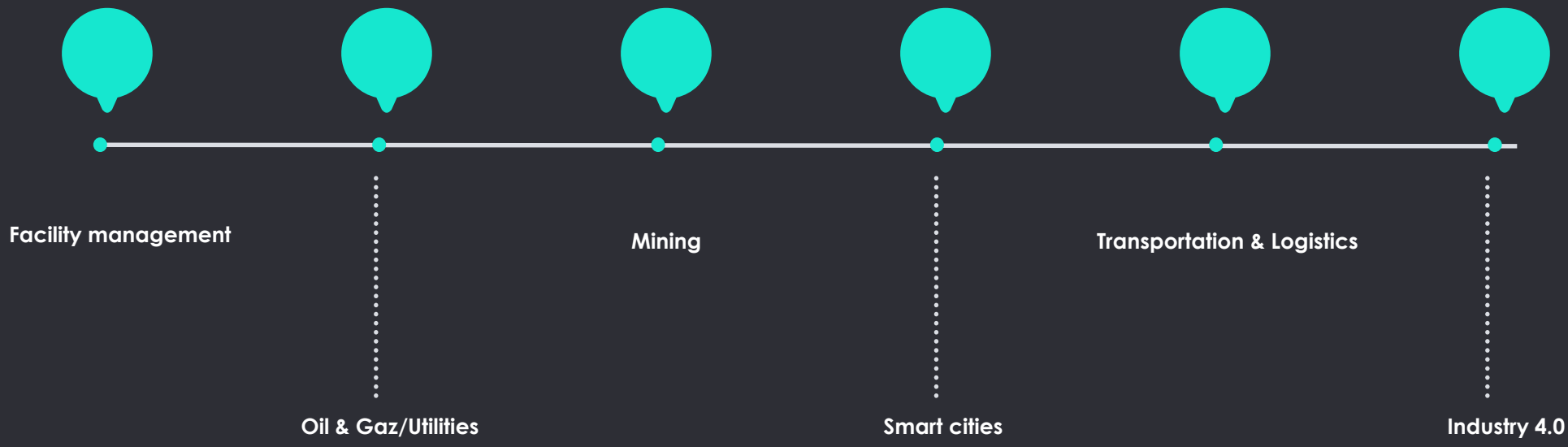
Example of AWS IoT MQTT client



MQTT : Client server publish subscribe messaging transport protocol
Subscribe → Message reception from IoT device
Publish → Message sending to IoT device



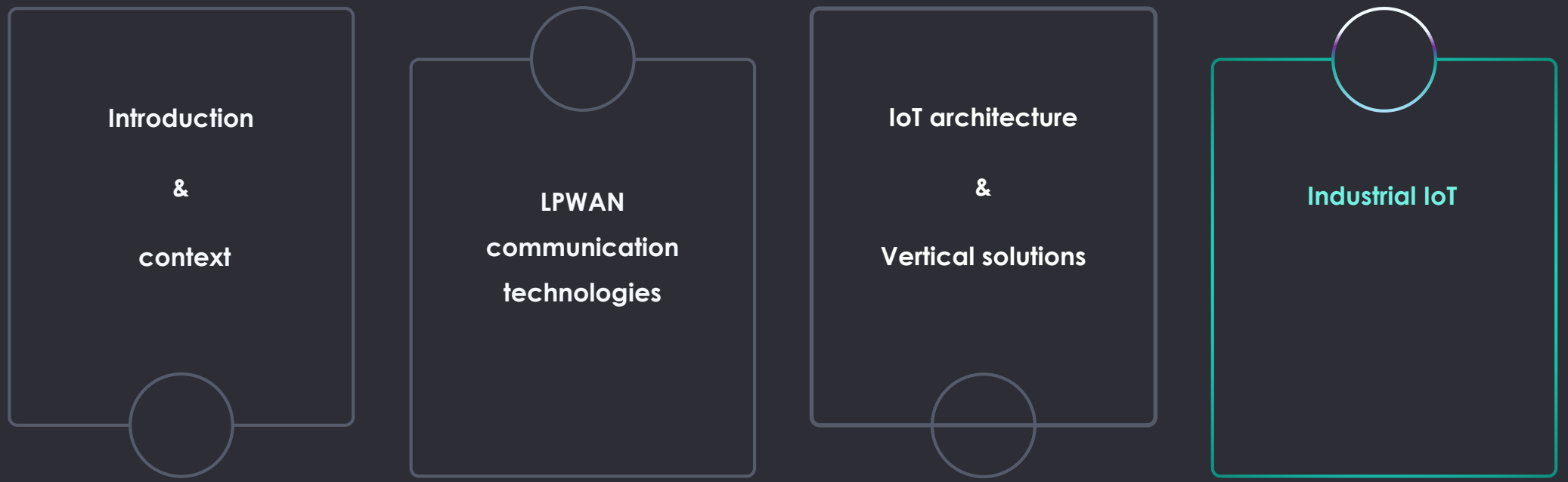
Vertical solutions



What about your IoT project

1. Is security critical for your use case?
2. Is latency critical for you? Do you need real time data and response

3. How much data do you need to send? How often?
4. What is the budget dedicated to the project? How much time do you have?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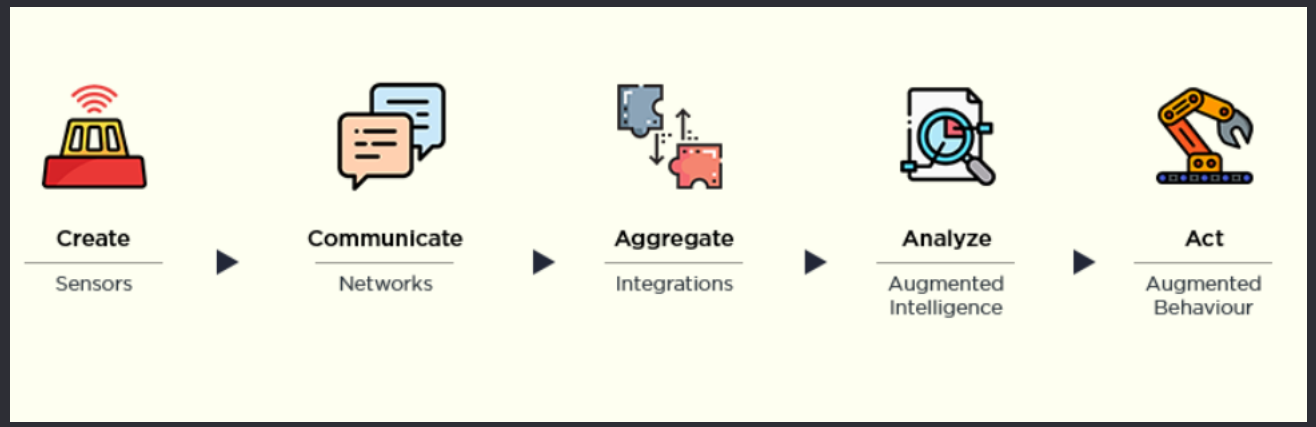
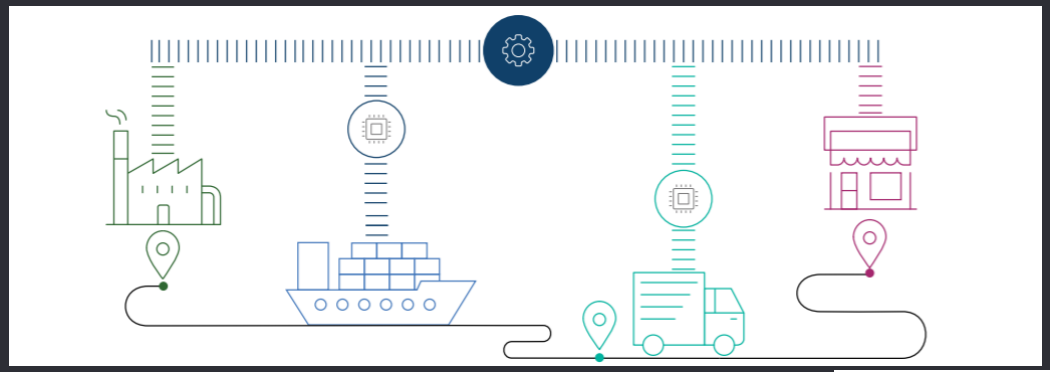
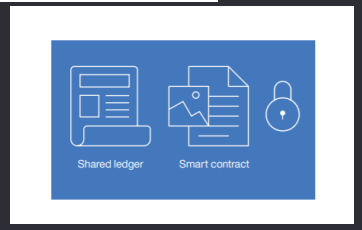
IoT and AI



- Boost operational efficiency
- Increase IoT scalability
- IoT devices as nervous system and AI acting like the brain

IoT and Blockchain





- Blockchain: shared ledger with no central authority
- Smart contract
- Monitoring of contract requirements with IoT
- Blockchain used to store those information in a centralized ledger

Conclusion

- Game changer
- Revolutionizing the world
- Trending new technologies are building our future
- Social impact

Q&A